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The impact of treatment intensity and human and social capital on survival of patients with colorectal cancer

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1. Introduction

In national health care systems, as in Great Britain and the Nordic countries, citizens do not have individual contracts that specify what they are entitled to from their health service. In these countries priority assignment of patients is determined by the parliament in terms of laws and regulations and by physicians in terms of clinical decisions. For instance in Norway, the Act on Patient Rights states that the allocation of health services should be determined by a combination of the seriousness of a patient's illness, the expected health gain of treatment and the health effect relative to the cost of treatment. The Act on Regional Health Authorities states that the aim of the health authorities (hospitals) is to provide high quality specialist health care on an equitable basis to patients in need, irrespective of age, sex, place of residence, material resources and ethnic background.

Although the goals of achieving equity in the allocation of health care resources are ambitious, the instruments for auditing whether these goals are fulfilled are not equally ambitious. Iversen and Kopperud (2005) explore whether laws and regulations that govern the allocation of specialist health care resources in fact are fulfilled. They find that accessibility and socio-economic variables play a considerable role in determining visits to a private specialist. With regard to visits to a hospital outpatient department these variables are not found to have significant effects.

Iversen and Kopperud (2005) employ survey data where only very broad groups of health services can be identified. The present paper studies equity issues in more details. We have access to patient level register data for one type of cancer disease; colorectal cancer. Since colorectal cancer is a serious disease with high mortality, equity in the treatment of the disease is likely to be an important health policy issue. However, the health authorities have taken no measures to monitor a possible impact of socio-economic variables on treatment and survival from cancer. Hence, this paper may be considered as a step in the development of data and analyses for supervising the achievement of equity goals by means of merged micro-data at the disease level.

Section 2 explains some basics of the disease we study; colorectal cancer. In section 3 we put forward our hypotheses and relate these hypotheses to the existing literature. Section 4 provides a description of the data set and Section 5 presents the estimation strategy and the results of the estimation. In the concluding Section 6 we sum up the results. Since the paper is preliminary and presents work in progress we also suggest improvements that are considered in future versions.

2. Study setting

Worldwide, colorectal cancer results in 437,000 annual deaths, making it the 3rd most prevalent cause of cancer mortality (Pisani et al., 1999). In Norway colorectal cancer is the most prevalent type of cancer, with average five years survival of less than 60 percent (Cancer Registry of Norway, 2003).

At the time of diagnosis colorectal cancers can be categorized in stages according to advancement, where the stages are defined according to some discrete factors. Continuous factors like the size of the tumor accounts for variation within each stage. In this paper we apply the Dukes staging system, which is one of the most frequently used. In this system there are four stages of advancement, in ascending order:

Dukes A: Cancer localized within the bowel wall
Dukes B: Cancer which penetrates the bowel
Dukes C: Cancer which has spread to lymph nodes
Dukes D: Cancer with distant metastasis

The intensity of the treatment is closely related to the advancement of the cancer. The treatment follows certain standard procedures (Norsk Gastrointestinal Cancer Gruppe, 1999), but there is room for individual variation. Colorectal cancer refers to cancer of the colon or the rectum. Unless the localization is specified, our use of the term “treatment” covers both types. Surgery is the most common treatment for colorectal cancer. If the cancer is limited to a polyp, the patient can undergo a simple polypectomy (removal of the polyp), or a local excision, in which a small amount of surrounding tissue is also removed. If the tumor has invaded the bowel wall or surrounding tissues, a partial resection (removal of the cancer and a portion of the bowel) is necessary, together with removal of local lymph nodes to determine whether the cancer has spread to this area. In cases where it is not possible to reconnect the two parts of the colon, a colostomy (an opening in the abdominal wall to allow the passage of stools) is performed. Even though in a majority of patients the whole tumor seems to have been removed by surgery, the cancer recurs in as many as 40 percent of these patients, and chemotherapy is also given to reduce the risk. There is some controversy about whether patients with Dukes B disease should receive chemotherapy. The patients in this group who are considered to be at higher risk of recurrence are given chemotherapy for six to eight months, and the remainder are followed up closely, generally without receiving chemotherapy. Patients who present with Dukes C cancer are typically treated for 12 months. With regard to radiation therapy, there are differences between colon and rectal cancer. Colon cancer is not usually treated with radiation therapy, although this may be an option if the cancer has invaded another organ or adhered to the abdominal wall. Radiation therapy is an option for all stages of rectal cancer, but its use increases with the stage of advancement. At follow-up all patients are checked for recurrence. Follow-up usually entails physical examinations and colonoscopies.

3. Hypotheses and existing literature

Our conceptual framework is within the tradition established by Grossman (1972). The flow of healthy time depends on one's the health stock. The health stock is created from a group of variables, among them is medical care, and the relation between these variables and health is modeled in terms of a production function. For our purpose healthy time is synonymous with being alive and we simply describe our hypotheses in terms of a function between certain variables and survival time after being diagnosed with cancer. In Section 5 about estimation strategy the functional form that is chosen will be explained.

We hypothesize that:

$$\text{Survival} = F\left\{\underset{+}{\text{treatment}}, \underset{+}{\text{human capital}}, \underset{+}{\text{social capital}} \,|\, \text{stage}\left(\text{human capital, social capital}\right)\right\} \quad (1)$$

In (1) survival is described as a positive function of the intensity of treatment, of the amount of human capital and the amount of social capital contingent on the stage of disease when the cancer is diagnosed. For most types of cancer it is well known that early diagnosis improves prospects of survival. Eq (1) allows for the possibility that the stage of advancement at the time of diagnosis may be influenced by human capital and social capital. Human capital is defined by the OECD as the knowledge, skills, competencies and attributes embodied in individuals that facilitate the creation of personal, social and economic well-being. This is perhaps a rather broad definition. In this paper we shall mainly associate human capital with the length of formal education a particular person has gone through. We realize that this is a narrow interpretation and the reason for it is mainly the type of data we have access to. Social capital is a concept with several dimensions. In their extensive literature review, Islam et al. (2006b) provide a description and discussion of the central concepts used in the theoretical and empirical literature. Firstly, social capital is divided into cognitive and structural components. While cognitive social capital refers to norms, values, attitudes and beliefs, structural social capital contains observable aspects of social organization, such as membership in formal voluntary organizations and participation in informal networks. Structural social capital and cognitive social capital are likely to interact. In empirical studies of social capital one often finds a distinction between individual and community social capital. This distinction corresponds to the distinction between variables at the individual level and the community level, and may reveal interesting information about the types of social capital in a community. While community social capital (CSC; for instance, total number of memberships in voluntary organizations) informs us about the aggregate level of interactions and networks in the community irrespective of whether or not a particular individual is part of the network, individual social capital (ISC; measured for instance by the number of networks and formal organizations in which an individual is a member) indicates the social capital of this particular person. Because of data availability our focus in this paper is on individual social capital. It is individual social capital in terms of an individual's marital status. At a future stage of the project we aim at extending the indicators of social capital.

We suggest that both human capital and social capital is related to the stage of disease at the time of diagnosis. Education is likely to contribute to the knowledge about symptoms of disease and also contribute to easy access to the health service for a diagnostic examination. Social capital, at least in our restricted sense of concept, is also likely to result in an early diagnosis. The argument is similar to the one put forward in Folland (2006). Folland argues that an individual will change his behavior toward risk upon experiencing an exogenous change in his social capital: when he marries, has children, acquires friends, or experiences a more socially active community. He and each of his valued relationships place a demand for the preservation of his life and health for which he accepts a responsibility to preserve. In our context this means that he is likely to give the fear of being diagnosed with a serious disease less weight and to have his symptoms examined at an early stage of disease.

Hence, we predict a tendency towards well educated married people being diagnosed with a better prognosis of survival compared with poorly educated unmarried people. According to (1) we also suggest that at each stage of disease human capital and social capital in addition to treatment intensity adds to survival. Well educated patients are usually in a better general health condition which is likely to make it easier to recover from a potentially aggressive treatment of the cancer. Well educated patients are also likely to understand and to comply with the many prescriptions and recommendations after an intensive stage of the treatment. Social capital pulls in the same direction both because the patient will put more effort in gaining health and because caring and reminders is likely to make it easier to be on the right track.

There are some studies of the relationship between cancer survival and socio-demographic variables. Goodwin et al. (1987) examine the effects of marital status on the diagnosis, treatment, and survival of patients with cancer in population-based data. They find that unmarried persons with cancer have decreased overall survival. Three complementary explanations for the poorer survival of the unmarried persons are suggested. First, unmarried persons are more likely to be diagnosed at a regional or distant stage. Adjusted for stage, unmarried persons are more likely to be untreated for cancer. Finally, after adjustment for stage and treatment, unmarried persons still have poorer survival. Hence, the results suggest that the favorable consequence of being married on overall survival is due to multiple beneficial effects; early diagnosis, choice of treatment, and response to treatment all seem to have effect.

There are at least three Danish studies with relevance to our topic. Johansen et al. (1996) analyze marital status and survival from colorectal cancer in a nationwide study. They find that adjusted survival among married patients diagnosed with colon cancer is significantly longer and conclude that marital status does predict long-term survival from colon cancer. Similar results are found by Villingshøy et al. (2006). Contrary to expectations they also find a significantly higher mortality among patients reporting increased contact with their children compared to patients reporting unchanged contact frequency. They suggest that low physical functioning of the cancer patient may have initiated more contacts. Hence, poor health may cause more contacts, and not the other way around. Finally, Fredriksen et al. (2008) differentiate between colon cancer and rectal cancer. For each of the two groups they investigate stage at diagnosis in relation to socioeconomic status nationwide in Denmark. A reduction in the risk of being diagnosed with distant metastasis was seen in elderly rectal cancer patients with high income, living in owner–occupied housing and living with a partner. Among younger rectal cancer patients, a reduced risk was seen in those having long education. No social gradient was found among colon cancer patients. Hence, the authors conclude that there are socioeconomic inequalities in the risk of being diagnosed with distant metastasis of a rectal, but not a colon cancer.

Auvinen (1992) studies social class differences in colon cancer survival in patients with colon cancer diagnosed in Finland from 1979-1982. He finds a clear social class gradient in colon cancer survival. The difference in the age-adjusted relative risk of death due to colon cancer between the highest and lowest social class is 19%. Stage of disease at diagnosis accounted for a substantial proportion of differences in survival. In Auvinen et al. (1995) the population is increased both regarding type of cancer and number of years observed. At the aggregate level the authors find improved survival for the higher social class compared with lower social classes. At a disaggregated level the results are more mixed. A statistically significant linear effect of social class on age-adjusted relative risk of cancer death was observed in six of 12 cancer types among men and in nine of 12 among women; and the risk was highest for those in the lowest social class. The relative risk of death due to rectum cancer is lower for social class I (highest) relative to social class IV (lowest) for both genders. For colon cancer there is only a social gradient in survival for women. The authors conclude that social class is an important determinant of cancer patient survival.

With individual register and census data for the whole Norwegian population Kravdal (2000) studies the social differentials in survival from twelve common types of cancer. He finds the all-cause mortality among cancer patients compared with similar patients without a cancer diagnosis is found to be related to education, occupation and income. Excess mortality adjusted for other factors are found to be about 15 percent lower for men or women who had completed a post-secondary education than for those with only compulsory schooling. In Kravdal (2002) marital differentials in survival are further explored. The excess all-cause mortality among cancer patients compared with similar persons without a cancer diagnosis is, on the whole, more than15% higher for never-married men, never-married women and divorced men, than for the married of the same sex. This protective effect of marriage is not due to stage, which is controlled for. Kravdal (2001) discusses possible mechanisms that may contribute to the explanation of the effect. He suggests that spouse and children may take the initiative to obtain a second opinion about the diagnosis, which may be important for the treatment. Second, they may get involved in the choice of type of treatment. Third, the type of treatment that is chosen may be rationed. Pressure from the family may have an influence on priority a particular patient obtains. Fourth, patients with family may be helped to follow instructions more accurately, and to take initiative to further consultation if they notice signs of recurrence or other problems during periods when patients are under less close medical surveillance. Finally, Kravdal suggests that the married may possibly be able to attract not only more treatment resources, but also more formal care resources. Due to insufficient data Kravdal is however not able to differentiate between these various explanatory factors in the empirical analysis.

Although the results from the existing literature varies somewhat, the trend seems to be that human and social capital have a positive impact on cancer survival. The present study adds to the literature by employing data that make it possible to estimate the contribution to survival from all three types of variables, i.e. treatment intensity, human capital and social capital. In particular, the opportunity to distinguish between treatment intensity and human and social capital has a potential of making an important contribution. Consider the estimation of survival with treatment intensity as an omitted explanatory variable. When treatment cost is included in the residual, unbiased estimates of the effects of the included variables require that treatment intensity is unrelated to human capital and social capital. However, we find it likely that these variables are correlated, and that the correlation may have both signs. Improved education is likely to make it easier to get better treatment because the patient is more knowledgeable about the disease and probably communicate more easily with the physicians. Also social capital is likely to help both because the patient has additional sources of information and perhaps also because of spokespeople who are capable of influencing the accessibility to superior treatment. According to Grossman (1972) an individual with a high stock of human capital is expected to be a more efficient health producer, i.e. that such an individual on the margin gets more out the resources by generate health days. If treatment resources are allocated in order to maximize total health benefit, more resources should be allocated to the efficient health producer. On the other hand, if decision makers consider equality of health, those patients with an abundance of human capital and social capital may be given relatively less intensive treatment. If these arguments are valid, omitting treatment intensity from the estimation will influence the impact of human capital and social capital on survival.

In (1) we have assumed that survival increases with intensity of treatment. However, we cannot disregard that most treatment is given to the patients with the most serious disease and poor prospects of survival. Even if treatment does not prevent death, it may extend the time to death somewhat and perhaps increase the quality of life. In this situation the probability of surviving declines with increased treatment.

4. Data and descriptives

The data set for this study consists of the control group of NORCCAP (the Norwegian Colorectal Cancer Prevention, see Bretthauer et al. (2002)), which was carried out in Norway in the period 1999-2001. From the Cancer Registry of Norway we have information about time of colorectal cancer diagnosis. In the period 1999 to 2003, 207 individuals with colorectal cancer from the control group were possible to classify within the Dukes staging system. The time window of the study ends in 2003. Table 1 shows the number of cancers according to stage of advancement and proportion of deaths within each stage. More than half of the cancers are Dukes C, while the proportion dead increases with stage of advancement.

Table 1: Total number of observations and proportion of deaths according to stage of advancement.

Dukes stage	**Total number**	**Proportion dead**
AB	69	0.10
C	114	0.39
D	24	0.83

From Statistics Norway we have information of time and cause of death during the period 1999 to 2003, length of education, marital status, gender and income. From Table 2 we see that there are some differences, but no clear trend in the distribution of gender, marital status and education according to stage of advancement.

Table 2: Descriptive statistics for discrete variables according to stage of advancement. M = 207.

Variable	Category	AB	C	D
Gender				
	Male	0.31	0.59	0.10
	Female	0.36	0.51	0.13
Marital status				
	Married	0.34	0.56	0.10
	Not married	0.32	0.54	0.14
Education (years)				
	Low (0-10)	0.37	0.56	0.07
	Intermediate (11-14)	0.31	0.53	0.15
	High and very high (15+)	0.33	0.58	0.09

The proportion of deaths according to stage of advancement, marital status and length of education is shown in Table 3. For stage AB marriage seems to be associated with a lower proportion of deaths while for stage D the opposite seems to occur. High education is associated with a slightly higher proportion of deaths for stage AB and a lower proportion of deaths for stage C and stage D.

Table 3: Proportion of deaths according to stage of advancement. M = 207.

Variable	Category	AB	C	D
Marital status				
	Married	0.07	0.38	0.92
	Not married	0.15	0.41	0.75
Education (years)				
	Low (0-10)	0.15	0.47	1.00
	Intermediate (11-14)	0.03	0.38	0.80
	High and very high (15+)	0.17	0.35	0.80

Treatment intensity is approximated by the cost of treating colorectal cancer at the individual level. The costs of outpatient and inpatient services are calculated from the reimbursement system by means of information provided by the National Patient Register and the National Insurance Administration. The cost of outpatient services is covered by fee for service, activity-based financing and block grants, and that of inpatient services by activity-based financing and block grants. The activity-based financing is based on diagnosis-related groups (DRG). The DRG system classifies hospital services into groups that are medically related and homogeneous with regard to use of resources. DRG is a way of describing the hospital's case-mix. In Norway there are about 500 different DRGs. Each DRG is given a weight that reflects the treatment cost. For outpatient services the fee for service only partly covers the true cost. On the basis of a Norwegian study (Samdata somatikk, 2004) we have adjusted all the fees from the National Insurance Administration by a factor of 1.5 so that they better reflect the true cost. During the observation period the DRG weights have changed in spite of no major changes in the treatment for colorectal cancer. The unit price for DRG has also changed[1], but we apply the DRG weight and unit price for 2003 for all observation years[2]. Some patients were treated for other diseases during the observation period, but we include only costs that are directly related to the treatment of colorectal cancer. We therefore disregard any relation between the treatment of colorectal cancer and other diseases.

Table 4: Mean cost of treatment according to survival status and education. Numbers in €

Survival status	Education	Outpatient	Inpatient	Total
Surviving				
	Low (0-10)	5,866	14,652	20,518
	Intermediate (11-14)	4,591	14,853	18,444
	High and very high (15+)	2,372	15,543	17,915
Not surviving				
	Low (0-10)	9,802	17,917	27,719
	Intermediate (11-14)	12,159	19,343	31,502
	High and very high (15+)	20,891	20,891	41,782

From Table 4 we see that for individuals alive at the end of the observation period, mean outpatient costs decline with length of education for the individuals alive, while the inpatient costs are almost similar. For the individuals not surviving, the outpatient costs increases, while they are almost the same for inpatient costs. If length of education predicts general health status, the relation between outpatient costs and education could be explained by the fact that individuals with long education who survive are in good health and in need of less treatment. For individuals with higher education who die, they are in so good health that they are able to receive more intensive treatment until they die.

5. Empirical strategy and results

In order to evaluate the effect of human capital and social capital on survival, we first estimate the effect of human capital and social capital on the probability of being diagnosed at different Dukes stages.

[1] Changes in the unit price for DRG can be explained by for instance changes in efficiency and input prices.
[2] One DRG was in 2003 equal to EUR 3706

We then estimate the effect of treatment intensity, human capital and social capital on survival. We first estimate overall survival without including stage of advancement. Then Dukes stages are included in order to see how stages predict survival. Finally, we divide the sample according to Dukes stages to see if treatment intensity, human capital and social capital have different effect on survival for each Dukes stage.

In the last estimation we study the estimation between human capital and social capital and treatment intensity.

5.1 Human capital and social capital and stage of advancement at the time of diagnosis.

To estimate the effect of human capital and social capital on the stage of advancement at the time of diagnoses, we let *j* refer to Dukes stage, *j = AB, C and D* and *X* be factors that may influence the probability of being diagnosed at Dukes stage *j*. The probability for individual *i* to be diagnosed with colorectal cancer at Dukes stage *j* is assumed to be given by the multinomial logit model:

$$q_{ij}(X) = \frac{e^{X_i \beta_j}}{1 + e^{X_i \beta_2} + e^{X_i \beta_3}} \tag{2}$$

where *i = 1, 2, …. N, j=AB, C and D,* β_2 and β_3 are parameters to be estimated by the model. Let $Y_{ij} = 1$ if individual *i* is diagnosed with Dukes *j*. From this we can derive the log likelihood function[3]

$$\text{LogL} = \sum_{i=1}^{N} \sum_{j=C}^{D} Y_{ij} \log q_{ij}(X) \tag{3}$$

The parameters in (3) are estimated by the maximum likelihood method[4]. The results from the estimation are reported in Table 5 We see that none of the explanatory variables have a significant effect on the probability of being diagnosed at different Dukes stages.

[3] For further details on multinomial logit, see Green (2002)

[4] Estimated with STATA release 8.

Table 5: Multinomial logit on the probability of being diagnosed according to stage of advancement. Number of observation 207. St.dev in brackets.

Dukes stage*	Variables	Categories	Results
Dukes C	Constant		2.545 (2.063)
	Age		-0.036 (0.035)
	Income		0.000 (0.000)
	Marital status	*Married*	-0.080 (0.322)
	Education	*Low (0-10)*	-0.065 (0.434)
		Intermediate (11-14)	0.079 (0.386)
	Gender	*Men*	0.412 (0.328)
Dukes D	Constant		1.850 (3.155)
	Age		-0.050 (0.054)
	Income		0.000 (0.000)
	Marital status	*Married*	-0.550 (0.495)
	Education	*Intermediate (11-4)*	-0.274 (0.777)
		Long (15+)	0.669 (0.618)
	Gender	*Men*	0.112 (0.515)

* Reference category is Dukes AB

5.2 Survival

Let t denote months after diagnosis, where t = 0 denotes the month of diagnosis and A refer to Dukes stage, $F^A(t)$ is the cumulative distribution of T and $1-F^A(t)$ is the probability of surviving to month t. Survival can be modeled in several ways, where a proportional hazard model and an accelerated failure time model are two alternatives. In a proportional hazard model the coefficients relate to a proportional change in the hazard rate and not to survival. We apply an accelerated failure time model since in this model it is easier to infer directly the response of survival time to the independent variables. The regression coefficients relate proportionate changes in survival time to a marginal change in a given regressor, with all other characteristics held fixed. Let T denote survival time and let x be a vector of explanatory variables. Assume that

$$\ln(T) = x\beta_A + z \qquad (4)$$

where β_A is a vector of parameters and z is an error term[5]. It is furthermore assumed that $z = \sigma u$, where $\sigma > 0$ is a scale parameter and u is a “standardized” random term with cumulative distribution equal to the Weibull distribution

$$P^A(u \le y) = 1 - \exp(-e^y) \tag{5}$$

From (5) and (6) we get

$$\begin{aligned} P^A(T \ge t) &= P^A(\ln T \ge \ln t) \\ &= P^A(x\beta_A + \sigma u \ge \ln t) \\ &= P^A(u \ge \frac{1}{\sigma}\ln t - \frac{1}{\sigma}x\beta_A) \\ &= \exp(-\exp(\frac{1}{\sigma}\ln t - \frac{1}{\sigma}x\beta_A) \\ &= \exp(-t^{1/\sigma}e^{-x\beta_A/\sigma}) \end{aligned} \tag{6}$$

Let $p = 1/\sigma$. Then the corresponding survival function is given by

$$P^A(T > t) = 1 - F^A(t \mid x, p) = \exp(-t^p e^{-x\beta_A p}) \tag{7}$$

where p represents duration dependency, which can be constant (corresponding to $p = 1$), negative (corresponding to $p < 1$) and positive (corresponding to $p > 1$). A positive duration dependency, implies that the probability of surviving increases over time, i.e. an individual who has survived for five years has a higher probability of surviving to the next period than an individual who has survived only two years. When p is one, the Weibull distribution is reduced to the exponential distribution.

Our dataset contains censored spells, since we do not follow all the individuals until they die. For those still alive at the end of the observation period, we only know that the duration was at least t_j. Consequently, the contribution to the likelihood of this observation is the value of the survival function, i.e. the probability that a duration of survival is longer than t_j. Let $d_j = 1$ if the *j*th spell is uncensored, $d_j = 0$ if censored. If the sample consists of *n* independent spells, the log likelihood function is then given by:

$$L^A(\beta_A, \sigma) = \sum_{i=1}^{n} d_i \ln f^A(t_i \mid \beta_A, \sigma) + \sum_{i=1}^{n} (1 - d_i)[1 - F^A(t_i \mid \beta_A, \sigma)] \tag{8}$$

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[5] From (5) we can find the expected survival time $E(T) = \Gamma(1 + \frac{1}{p})e^{x\beta_A}$, where the $\Gamma(.)$ is the gamma function and equal to a constant. The log is then given as $\log E(T) = x\beta_A + \log\Gamma(1 + \frac{1}{p})$.

The results of the estimation are shown in Table 6. The introduction of Dukes stages as dummy variables distinguishes model 2 from model 1

Table 6: Results from the estimation of treatment intensity, human capital and social capital on survival. Number of observations 207. St.dev in brackets.

Variables	**Category**	**Model 1**	**Model 2**
Constant		5.02 (1.76)***	6.82 (1.67)***
Outpatient		-2.5e-06 (7.6e-07)***	-1.3e-06 (7.0e-07)*
Inpatient		-3.5e-06 (1.2e-06)**	-3.5e-06 (1.5e-06)**
Marital status	Married	-0.134 (0.246)	-0.151 (0.225)
Gender	Women	- 0.015 (0.247)	- 0.044 (0.227)
Education	Intermediate(11-14)	0.039 (0.284)	0.431 (0.273)
	Long (15+)	0.280 (0.327)	0.558 (0.309)
Dukes stages	Dukes C		-1.339 (0.380)***
	Dukes D		-2.675 (0.454)***
$/\ln\_p$		*0.017 (0.107)*	*1.32 (0.187)*

**** significant at 1 % level, ** significant at 5% level and * significant at 10% level*

From Table 6 we see that outpatient and inpatient costs are negatively related to survival in both model 1 and model 2. In model 2 we see that Dukes stages are an important predictor for survival in the sense that more serious stages decrease the survival time. The duration component, *p*, is not significantly different from zero.

In Table 7 we have estimated the effect of treatment intensity, human capital and social capital on survival within each Duke stage. For Dukes AB we find that outpatient costs have a negative impact on survival and for Dukes C we find that inpatient costs are negatively associated with survival. Education longer than 15 years increases survival for patients in Dukes D.

Table 7: The effect of treatment intensity, human capital and social capital on survival according to Dukes stage. St.dev in brackets.

Variables	**Category**	**Dukes AB**	**Dukes C**	**Dukes D**
Constant		-2.382 (4.916)	7.233 (1.980)***	4.625 (3.047)
Age		0.109 (0.088)	-0.038 (0.031)	-0.041 (0.046)
Outpatient		-0.00001 (6.2e-06)**	-1.1e-06 (7.3e-07)	1.12e-06 (2.01e06)
Inpatient		-0.00001 (7.0e-06)	-4.7e-06(1.6e-06)***	-5.64e-06 (4.0e-06)
Marital status	Married	-0.857 (0.716)	-0.006 (0.276)	-0.663 (0.429)
Gender	Women	1.047 (0.816)	-0.206 (0.258)	0.584 (0.436)
Education	Intermediate	1.164 (1.105)	0.172 (0.308)	0.718 (0.538)
	Long	1.422 (0.921)	0.279 (0.349)	1.740 (0.705)***
/ln_p		0.155 (0.347)	0.225 (0.132)*	0.264 (0.187)

5.3 Treatment costs

In Section 3 we argued that the relation between human and social capital and treatment intensity may have both signs, depending in whether efficiency reasons in terms of maximizing total survival time or equity reasons dominate treatment decisions at the clinical level. By means of an ordinary regression analysis (OLS), we have estimated the effect of human capital and social capital on treatment cost. From Table 8 we see that outpatient costs increase with stage of advancement, i.e. outpatient costs are higher for Dukes C and Dukes D than for Dukes AB and increase with income. Inpatient costs decrease with age and if the individual is a woman. The inpatient costs increases if the individual dies. There are no effects of education and marital status.

Table 8: The effect of human capital and social capital on treatment intensity, according to Dukes stage. St.dev in brackets.

Variable	**Category**	**Outpatient**	**Inpatient**
Constant		18,090.1 *(91,390.2)*	277,523.9 (70,034.4)
Income		0.07 *(0.041)* *	0.015 (0.031)
Income(quadratic)		0.00 *(0.00)*	0.00 (0.00)
Age		-367.81 *(1,398.38)*	-2,365.67 *(1,068.24)* ***
Marital status	Married	4672.4 (12786.9)	-2142.8 (9882.0)
Gender	Man	7102,91 *(13,163.96)*	18,989.00 (10,722.06)**
Death		-12,093.80 *(15,248.46)*	28,240.47 (11,643.16) ***
Stage of	Dukes C	68,367.07 *(14,052.46)****	18,075.99 (10,722.03) *
advancement	Dukes D	61,806.85 *(23,160.79)****	-7,050.62 (17,695.97)
Education	Intermediate	-12,824.10 (15,205.29)	-2,286.13 (11,729.57)
	Long	11,373.70 (18,545.35)	2,062.84 (14,156.62)
$R^2(adj)$		0.09	0.06

6. Concluding remarks

The main results of the study may be summarized as:

- There is no found association between human and social capital and stage of advancement when the cancer is diagnosed.

- The stage of advancement when the cancer is diagnosed is the main predictor of survival time.
- There is no effect of marital status on survival.
- For Dukes D there is a positive effect of higher education on survival
- There seems to be a negative association between treatment intensity and survival
- There is no association between marital status and education and treatment costs
- There is a positive association between stage of advancement and treatment costs

As a general conclusion we suggest that an association between our indicators of human and social capital and survival hardly seems to exist. The same conclusion applies to the relation between our indicators of human and social capital and treatment intensity. An interpretation of the results is that disease severity is the overriding criterion for allocating treatment resources to patients with colorectal cancer.

Our results are contrary to what is found by Kravdal (2000, 2001) and others. A possible reason may be that our study has too few observations to demonstrate statistically significant effects of education and marital status on survival and treatment intensity. In future work we shall apply an alternative staging system that allows for more observations to be included.

We shall also put more effort into the model that generates our hypotheses. In the present version it may be claimed that it is not clear from the model whether a structural or a reduced form model that is estimated.

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